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Impact of Coating on Performance of 150 CC Pistons

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Abstract- The thermal energy generated in IC engine fire chamber cannot be completely converted into a useful work due to loss of heat transfer. This leads to a decrease in engine performance. To counteract this, pistons are bound with various substances such as molybdenum disulphide, chromium nitrides and other substances. These thermal insulation covers improve engine performance by preventing heat loss. In this trial, the effectiveness and efficiency of Tungsten Carbide coated piston for different layer was investigated. So here we introduce a Tungsten Carbide coated piston which performs quiet better than uncoated piston, so that durability of piston will increase from uncoated piston. From analysis we can see that coated piston runs more than 30% extra which increases piston life and it reduces maintenance.

Keywords: - Piston, Tungsten Carbide, Temperature, Temperature Probe, Heat Flux, Stress, Strain, ANSYS version (18).

I. INTRODUCTION

The most cost effective way to reduce the oil consumption is to develop more efficient combustion engines. Today, about 40-45% of fuel energy is converted into a useful work, while remaining fuel energy in form of heat losses is transferred to environment. One of the possible solutions of decreasing heat losses from the engine is by insulation of piston coated with Tungsten carbide; all possible measures of improvements are in the scope of interest. Therefore this master thesis was carried out.

The theoretical study was focused on about appropriate materials, industrial applications and the state of the art research in the area of coating. For the experimental studies, three selected materials have been selected that are documented in the engine and turbine industries. Piston prototypes and samples for material study were coated using five thicknesses 0.5 µm to 0.25 µm and a coating of Tungsten Carbide powder coating. Heat capacity, apparent heat distribution and low durability are measured for each garment. Stability under high Temperature variations is tested on a machine specifically designed for hot cycling. The integrated pistons have been tested in a single cylinder research engine, to ensure the strength of the insulation. Due to the negative impact of partitioning the fire process and the overall efficiency of the engine, it was difficult to obtain results.

A trend showing a decrease in heat loss with an increase in the stiffness of the firm was observed. During both engine and thermal cycling tests of different thickness of Tungsten Carbide powder coating from 0.05 µm, 0.1 µm, 0.15 µm, 0.20 µm, 0.25 µm, 0. 3µm. The best result obtained to acquire minimum heat loss during combustion and obtained no deformation during high heat in general 150 cc pistons, the best result obtained when we coated piston with 0.25 µm with Tungsten Carbide powder coating.

Reduction of Greenhouse Gases (GHG) emission is one of highest importance in all industrial sectors around the world in order to prevent the unwanted climate changes. According to International Energy Agency (IEA), without preventing actions the energy related CO2 emission will be more than double by

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2050 and increased oil demand will create more concerns about supplies. Among all countries a number of international and national procedures and commitments were already implemented in the last years. In the transportation sector however, due to its rapid growth the general release of GHG has recently increased. On the IEA's technical roadmap it is stated that today more than 55% of the fuel consumption of the vehicles and three quarters of them are used on the roads.

II. APPLICATIONS AND PRINCIPLE

1. Classification:
Thermal engines are energy-efficient converters that convert heat energy, produced during a gas-fired fire in the air, and perform the function of the machine. The rotation is performed by repeated piston movements connected to the crankshaft with a connecting rod. Engines with integrated combustion chambers are classified as internal combustion engines (IC).

The characteristics of the engine element are the use of active liquid heat and the increase in pressure during the thermal pressure of the fuel. These are heat engines, where the ignition is started by a sparkplug. IC engines, depending on the applicable principle, can function as strokes with a stroke. However, the engines operating in a four-stroke cycle are within the title of this thesis master.

2. Four-Stroke Cycle:
To complete the thermodynamic cycle in a four-sided IC engine, the pistons must complete four movements near the cylinder corresponding to the pulse, pressure, force and discharge lashes.

Initially, in the feeding phase the piston descends downwards from the dead upper center (TDC) to the lower dead center (BDC) increasing the operating volume of the chamber. The pressure is reduced inside the cylinder and the charge of fresh air is loaded into the chamber via open opening pipes during piston movement. When the piston reaches the BDC, the feed valves close. In the pressure mode all the valves are closed and the piston goes up pressing the air charge that was loaded in the previous section.

The diesel injection occurs as the piston reaches the TDC and is followed almost immediately by burning. In the third phase, hitting hard, the crankshaft begins its second rotation in the cycle. The fire spreads rapidly in the room as the temperature rises and the compound pressure increases. As the piston moves downwards it transfers mechanical power to the crankshaft.

III. MECHANISM OF POLLUTANTS FORMATION MECHANISM OF POLLUTANTS FORMATION BY PETROL ENGINE

Pollutants are produced Air pollutants are produced by incomplete combustion of air by insufficient combustion of air by the incomplete combustion of a mixture of air particles in the fuel component of the fire chamber.

The main pollutants resulting from extinction due to incomplete fires are:

- Carbon monoxide (CO)
- Hydrocarbons (HC)
- Oxides of nitrogen (NO)

Other products produced are acetylene, aldehydes, etc. In that case, the fire would be the only product out of the exhaust if the end product in the line would be harmless water vapor, and carbon dioxide, which is a by-product, would therefore not be directly harmful to humans.

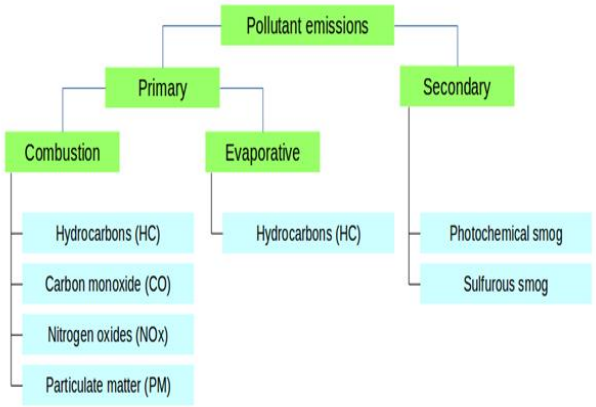

Fig 1. Shows Pollutant Emission.

IV. LITERATURE REVIEW

N.Kellinga1 M.Woydta1 L.-M.Bergerb: Two new substoichiometric Titania (TiOx) coatings selected for application cylinder liner were added to the gray cast iron GG20HCN model with high carbon content by

plasma spraying. First, the cover of TinO2n-1 was prepared by plasma spray (APS) using Magnéli spray powder. Second TiO1.95 - x coverage was applied via a vacuum plasma spray (VPS) using commercial, integrated TiO1.95 powder.

The extreme behavior of these covers under anointing conditions was compared to a statue not fitted with this gray metal. As APS-sprayed counters Mo-NiCrBSi piston ring coating (MKP81A®), advanced HVOF-sprayed WC/Cr3C2-based (MKJet502®) rings and non-commercial prototype APS-sprayed TinO2n-1 and Fabrics of APS-sprayed (Ti, Mo) (C, N) + 23NiMo (TM23-1) suffered greatly.

Dual interactions with model engine designs based on esters and polyglycols were studied under mixed / boundary lubrication using the BAM test method. Lubricants were industries that filled engine oil, lubricants containing low-SAP ester (sulfur-ash-phosphor) and / or bio-no-tox properties as well as lubricants made of polyglycole. Engine oil based on ester and polyglycole responds both to the bio-no-tox process and has no polymer. They follow different strategies to reduce zinc, phosphorus and sulfur to ensure low ash content.

Both TiOx coatings designed for cylinder liners meet or exceed the wear resistance of gray metal with high carbon content when paired with APS-sprayed TinO2n - 1 or Mo-NiCrBSi piston ring. Overall, almost all pairs of APS TinO2n-1 coating wear prices were lower than those of VPS TiO1.95 - x coating.

To detect tribological behavior under off-off, dry conditions, additional tests were performed under 22 slide conditions and 400 °C at a faster speed of 1 m/s compared to sintered polycrystalline Al2O3 as an example. .

N. Dolatabadi, aM. Forder, aN. Morris, H. Rahnejat, aS. Howell-Smith a (2006): IC engines contribute to global warming by enormous fuel consumption and emissions of fossil fuels. New technologies such as cylinder de-activation (CDA), heat treatment after decontamination, facial contouring and coverage are proposed to improve the fuel economy and reduce emissions. Therefore, studying the coverage technology using a multi-physics analytics model of a high-pressure ring engine is important to find ways to promote energy saving. This paper introduces a multi-dimensional, varied physics model of compression ring-cylinder bore connector, using three boreholes. The model contains the flexibility of the rings, autopsy, heat transfer and gas explosion. The tribological and thermal properties of advanced coatings, such as Nickel Nanocomposite (NNC) and carbon-like carbon (DLC) compared to stainless steel molded as a basic line arrangement. Such a comprehensive analysis to date has never been reported in open source literature, especially with the actual contributions made by including key components of some of the most efficient running engines for race engines. Depression and FMEP were tested in a dynamometric test, representing the corresponding Global Vehicle Testing Cycle (WLTC).

The coverage of the NNC marks a promising development for development. DLC coverage is dangerous with power loss and FMEP, although it can effectively improve the branding of a fire chamber. Differences in power outages for elevated ball bearings are represented as fuel and CO emissions, using theoretical and technical relationships. For the first time this paper shows that improved coverage can reduce the negative effects of spark ignition (SI) engines, with significant effects when used on fuel-efficient motor vehicles.

Jesse G. Muchai, Ajit D. Kelkar, David E. Klett & Jagannathan Sankar (2001): The purpose of this paper is to investigate the heat of pistons and the distribution of pressure from the various covering layers of Partially Stabilized Zirconia (PSZ) barriers for performance in diesel applications. This analysis is based on the hypothesis that the covering thickness affects the heat transfer and distribution of temperatures in the piston.

A dynamic gas circuit simulation code was used to detect thermal boundary conditions in the piston at that time, and a 2-D ax symmetric Finite Element Analysis (FEA) using ANSYS was performed to assess the distribution and pressure in the piston as a magnification function. Cover readings include 0.1, 0.2, 0.3, 0.5, 1.0, 1.5, and 2.0mm.

The results show an increase in piston temperatures with increasing coverage growth. The maximum pressure on the surface of the piston placed at the top was high while the pressure of the substrate was less than the pressure of the cover material at all the cover sizes. In addition, the analysis showed that the

pressure of the visible connector in all combined conditions is low enough to be expected for the separation of the garment. FEA results suggest a maximum coverage of 0.1 to 1.5 mm for diesel engine application to avoid unnecessary stress on ceramic.

Arthur Rozario, Christoph Baumann, Raj Shah (2019): The piston group is responsible for contributing to ~ 50% of variant engine losses, which ultimately leads to fuel consumption. This is combined with the fact that gasoline is a limited utility associated with CO2 emissions; there is an increased need for more efficient, continuous vehicles that load the piston ring. Currently, there are many studies that are already studying the connection of a piston ring to a cylinder liner.

M.Cerita V. Ayhanb A. Parlakc H. Yasara (2009): The effects of thermal coverage that are part of the distribution of piston temperatures and the cold distribution of HC spark ignition (SI) engine are investigated numerically and experimentally. Thermal analysis is performed on both standard and wearable pistons using a commercial code, which is ANSYS. Engine testing was carried out on a single cylinder, a cool SI engine of water in both standard and wearable cases. Analysis results show that the temperature of the upper part of the enclosed piston is increased to 100 ° C, leading to an increase in the temperature of the air-and-oil mixture in the cracked and wall-mounted regions. Therefore, the cold onset of HC emissions is significantly reduced compared to conventional engine without damage to engine performance. The main decrease in HC emissions was 43.2% compared to the standard engine.

Zhimin Yao Zuoqin Qian (2013): Nano ceramic coatings have slow-moving thermal properties that can provide good thermal insulation properties, so they are widely used in industrial construction such as thermal insulation coatings (TBCs). In the design of internal fire engines, TBCs have been used in parts of the fire chamber to improve engine performance. In this paper, improvements in the performance of natural gas engines are shown when spraying an aluminum alloy piston with Y2O3 with slightly sticky ceramic.

Thermal analysis of the applied environment was used to determine the effects of ceramic coating on temperature distribution. The output was compared with the results from a standard unripe piston using a limited element method. The results show that the temperature above the bound piston is much higher (approximately 44% or 153 ° C higher) than that of the uncovered piston. This high temperature of the fire chamber leads to better engine performance and lower temperature.

At the same time, the temperature of the coated piston substrate is much lower (about 12% or 43 ° C below) than that of the uncovered piston. The lower temperature of the metallic substrate provides better protection against piston fatigue.

Christian Binder, Fahed Abou Nada, Mattias Richter, Andreas Cronhjort and Daniel Norling (2017): Diesel engine manufacturers are striving for improved performance. Therefore, reducing the heat loss of the cylinder is becoming increasingly important. Understanding how space, thermal heating, and engine operating conditions affect heat transfer to the walls of a fire chamber is essential to the future reduction of cylinder heat loss. This study investigates the effect of a 1mm-thick thick-sprayed yttria-stabilized zirconia (YSZ) coating on the piston.

A piston attached as well as a piston of the same metal is compared to another according to the test temperature details, the heat transfer rate you recorded in the piston coil, the ambient temperature, and the local global warming. Excess temperature was measured at different crank angle positions using phosphor thermometry.

The fuel was selected to be n-heptanes to facilitate the measurement of surface temperatures during non-combustible, efficient operating conditions. By taking a single thermal heat inside each piston, the local area temperature is immediately calculated using the thermal transfer rate in the oil piston cooling gallery and surface temperature measurements. The results of this study show that the local temperature variations are the same for both pistons. Rapid heat outages at a time the combustion force however is much greater for a steel piston than a closed piston. The heat dissipation analysis also shows that the heat is slowed through the piston by a zirconia-reinforced zirconia coating.

Zhimin Yao Wengui Lib (2014): Aluminum alloys in internal combustion engines (IC) can withstand thermal damage. Such heat damage can be

minimized using thermal covers (TBCs). In this study, TBC Nano yttria slightly reinforced zirconia (PYSZ) was used as a powder blended in aluminum alloy piston using an air plasma spray (APS) method. The preparation and use of Nano PYSZ composite powder is essential for its effectiveness as a TBC. The benchmarking of IC engines is done to provide a basis on which TBC performance can be judged. The microstructure of the Nano PYSZ composite powder and thermal insulation coatings were tested using three tools: electron microscopy (SEM), field extraction scanning electron microscopy (FESEM) and X-ray powder diffraction (XRD).

The results from this study show that TBCs of Nano PYSZ ceramic, applied to an aluminum alloy piston using a plasma spraying system, (a) have a high-density Nano structure, (b) can withstand high thermal shock to the cylinder and) maintains both stable macro and structural features during the IC engine engine cycle. Thermal insertion features of TBCs were also examined. Thermal analysis refers to the distribution of temperatures across both pistons and aluminum alloy substrate. The results show the effectiveness of TBCs in lowering the temperature of the aluminum alloy substrate above the piston. Another advantage is that the piston can work effectively at high temperatures.

Specifically, as the thickness of the ceramic coating increased from 0.1 mm to 1.4 mm, the maximum temperature of the pistons covered with TBCs increased from 399°C to 665°C. The high temperature of the alloy substrates simultaneously decreased from 336°C to 241°C. clearly demonstrates the excellent thermal insulation properties of TBCs and shows that the effectiveness of thermal insulation can be greatly improved by increasing the size of the ceramic layer.

Selvam M, Shanmugan S, Palani S (2018): Experimental research regarding the coverage of ceramic in diesel engine material to test its effectiveness in relation to various loads. Powered by Kirloskar single cylinder diesel engine; in addition, engine performance, discharge, and fire temperature have been analyzed by piston mounting on a diesel engine (D100) and biodiesel (B100). Yttria-reinforced zirconia is a ceramic agent bound to the piston with the help of a plasma spray injection method. After test results based on the comparison of the enclosed and unlocked piston, it is shown that the piston mounted performs best with increasing temperature, reducing further fuel consumption in all used loads. The extraction is also tested with special test equipment and shows that hydrocarbon and carbon monoxide are some of the most common pollutants that fall into a closed piston than an unsealed piston.

However, there is an increase in nitrogen monoxide where it is controlled by varying the time of injection and pressure by developed injectors according to research. One of the advantages of this thermal insulation material is that the thermal stress on the surface of the material can be reduced to a great extent. The fire has a high degree of heat dissipation and pressure due to the total heat inside the enclosed room without being forced into the surface of the surrounding objects.

Ravindra Gehlot, Brajesh Tripathi (2016): This paper is about further analysis of the temperature of the diesel engine of a disk engine wrapped in a clay cloth with holes in its surface. Distribution of temperatures at the top of the piston and substrate surface is investigated using a software based element called Ansys. Yttria-reinforced Zirconia is used as a ceramic coating used in Al-Si piston crown. The 2 dimensions of the ceramic top cover are about 0.4 mm and the NiCrAl bond cover is 0.1 mm.

Temperature distribution is investigated by selecting different radius of holes created in the ceramic cover area of approximately 1.5 mm, 2 mm and 2.5 mm. From the results it is evident that the surface (water-bound) temperature rises by increasing the radius of the holes. The maximum temperature of the mold occurs in the highest part of the holes about 2.5 mm. Compared to the hole-free cover, a higher increase in the maximum temperature of the piston occurs with the perforated cover. However, the temperature of the substrate decreases by increasing the diameter of the holes.

A. Manoj Babu, C. G. Saravanan, M. Vikneswarana, V. Edwin Geob J. Sasikala J. S. Femilda Josephind Debasish Dase (2014): The low carbon biofuel (pine oil) found in the pine tree is supplied with improved octane fuel fuels and can be used for SI engine systems. In order to use pine oil mixing for fuel efficiency, engine design modification is required. This work investigates the apparent changes in the characteristics of the port engine that will release the SI engine due to the small barrier

cover created by the piston crown using the Micro-arc oxidation process.

In addition, an endoscopic optical blinding procedure was adopted to compare the flames of the open and closed piston engines sprayed with pine oil mixture. The piston-mounted engine driven by pine oil mixes exhibited high cylinder pressure and heat dissipation rate.

Harish Venu & Prabhu Appavu (2019): The purpose of this work is to increase the performance of a diesel-powered engine using a hot piston-coated valve used with Jatropha biodiesel-diesel compounds. To seal the thermal barrier, Yttria zirconia-reinforced (YSZ) is preferred due to its high thermal strength compared to other protective materials such as mullite, zirconia, ceramics, magnesium silicate, and silicon carbide etc. -YSZ is bound by a process of plasma spray thickness of 200 µm around the piston crown. The test fuel used is DF100 (100% diesel fuel), JB20NE (20% Jatropha biodiesel + 80% diesel operated at non-coated engine) and JB20CE (20% Jatropha biodiesel + 80% diesel fuel operated at YSZ camera).

Test results showed that JB20CE resulted in a 10.6% increase in the efficiency of the thermal brake and 20.97% reduced the use of the specific brake used since the YSZ cover acts as a potential insulator for high temperature inside the fire chamber reduces energy losses followed by fire efficiency, air-and-fuel combinations and improvements. Wise emissions, JB20CE performance resulted in a reduction in hydrocarbon and carbon monoxide emissions by approximately 41.67% and 33.33% due to improved fuel oxidation and thermal efficiency provided by YSZ insulation.

S. Balamurugan1, V. Bharath2, E. Boopathiraja3, K. M. Boopathy4, K. Chandrasekar (2020): The piston is made of alloys which is an integral part of the internal combustion engine. The high temperature generated by the engine can help with high temperature pressures.

Without a proper heat transfer machine, the piston crown will work inefficiently. To reduce wear and heat stress we use ceramic coating in the piston. The use of clothing in things now expanded into global production to reduce repair costs and improve component performance.

P. D. Patel, R. N. Patel, H. C. Patel, Pradip M. Patel (2013): Various ground treatment methods are used in parts of the cylinder piston group (CPG). The piston ring is a very sensitive element and the development wear is done by hot spray methods. Among the hottest spraying methods, plasma spraying is the most commonly used method in the automotive industry because it has high spraying and placement, the process uses inexpensive and easily available fuel gases, the process requires low heat and temperature during spraying, the technical reliability of plasma systems is well established in industrial applications, and spray conditions can be easily controlled in various applications.

In particular, molybdenum Enhancing the service life of the internal combustion engine component and improving the efficiency of engine coatings designed for plasma atmospheric spraying increases wear resistance and heat, so this adhesion technology has been marketed for use in the automotive industry. Resistance to wear of plasma molybdenum coatings acting on piston rings has been investigated in this study. The performance parameters of the C I engine (according to IS 10000: Part 8) and the wear (Endurance Test) of the piston and cylinder Assembly (according to IS 10000 Part 5) are also made without the use of moly camera rings.

Ch. Venkata Rajam · · P. V. K. Murthy, M. V. S. Murali Krishna (2014): A simple and powerful prepared piston is fitted with bio-fuel zirconium. LHR ground engines use ceramic coverings on the piston, liner and cylinder head, while LHR intermediate engines provide air gap to the piston and other components. It is necessary to test the tightened piston to withstand pressures and difficulties.

In this paper, the bound piston was tested by vonmisses using ANSYS for the load applied above. The pressure distribution analysis was performed on various parts of the bound piston to detect pressures due to gas pressure again hot variation. Vonmisses pressure increases by 16% and deviation increases after proper use. But all parameters fit well with the design considerations.

G.V.N. Kaushik (2020): In an IC engine, the Piston is one of the most important and complex parts. With increasing power and engine performance, high thermal load and thermal pressures operate on the piston, thereby, reducing its lifespan. It is important

to keep the Piston in good condition in order to maintain good engine performance. Piston fails mainly due to Hot Circumstances. In this paper a 3D piston model is developed, structural and temperature analysis is performed by ANSYS using 5 different building materials to obtain heat and heat distribution, find the total temperature and compare the operating values of the different Piston materials used.

V. CONCLUSION

Piston rings of reciprocating engines have several functions apart from sealing the gas pressure which affect performance of engine. From literature it appears that piston ring can be designed using experimental, analytical and numerical techniques. Structural design of piston rings using FEA is not studied adequately. Hence, design validation can be carried out using commercial FEA tools such as ANSYS, Abacus, etc.

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